Totally Active NOVA Configuration:

A Case for the Vee Design

Hans Jostlein, July 17, 2004

ABSTRACT

The Totally Active Scintillating Detector (TASD) appears to have several advantages.
It also poses some engineering challenges.
One of them is the stress from hydrostatic pressure in the extruded PVC tubes.
In the TASD, this pressure is no longer resisted by particle board planes.
One can, of course, increase the tubes' wall thickness, at some cost in materials and dead detector mass. The wall thickness may need to be substantial, to counteract the creep behavior of PVC.
An alternative is to constrain each set of many layers (half the detector, perhaps) by "bookend" type hard walls. The remaining hydrostatic forces act only on the extrusion ends and outer edges, where the resulting stress is much less severe.
For a traditional XY layout, made from horizontal and vertical tubes, this scheme cannot work; the pressure in the vertical tubes is very large at their bottoms (1.4 atmospheres), while it is near ambient for all horizontal tubes (which are vented at each separate extrusion). A Vee-type arrangement has nearly uniform hydrostatic pressure at all adjacent cells, which allows bookends to constrain those forces effectively.
We present here such a layout (see Fig. 1) , along with concepts of how the sloping floor can be made; a concept of moving work platforms for installation; and a concept of support and gangways to access the electronics everywhere on the detector.

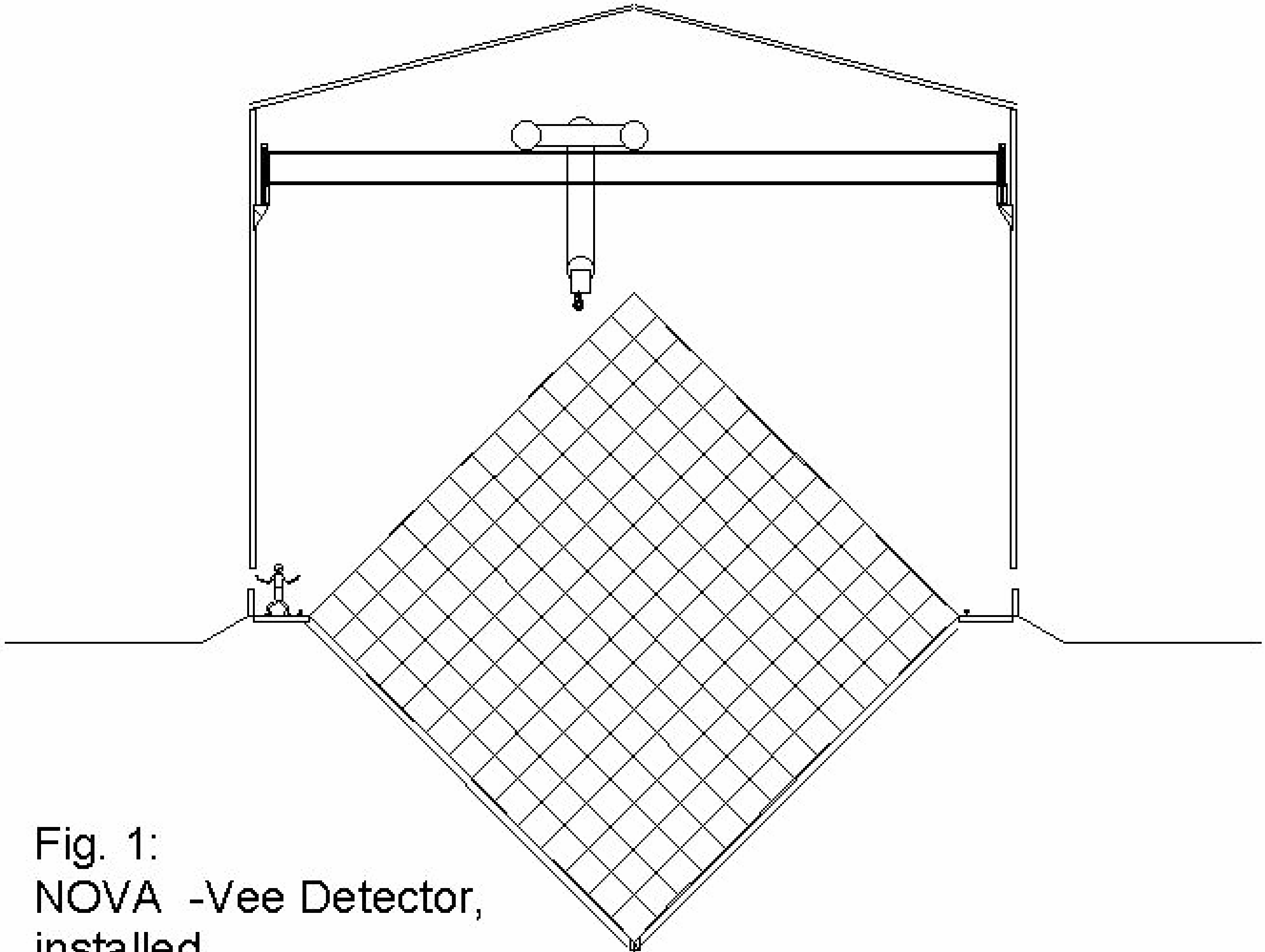

Fig. 1:
NOVA -Vee Detector,
installed

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The Pressure Problem

FEA calculation carried out to-date have shown that the PVC cells will resist the hydrostatic force if a yield pressure of 6000 psi is used to describe the PVC material. There is some concern that PVC will creep significantly even at stresses as low as 1000 psi during the life of the detector. Even if 1000 psi is found to be safe for the long term, wall thicknesses would have to be doubled.

If the pressure forces (in beam direction, principally) could be canceled out between adjacent planes, then only the first and last plane would need additional support, such as a rigid wall ("bookends").

In the "XY" configuration, consisting of alternating horizontal and vertical tube planes, this is not the case. The vertical tubes suffer the full hydrostatic pressure at their bottoms, while the horizontal tube only experience the hydrostatic pressure at a depth corresponding to an extrusion width (about 1 meter). Consequently, if the vertical tubes bow out due to yield and creep, they will act to compress, and ultimately flatten, the horizontal tubes. This can happen even if the detector end planes are constrained.

Instead, one can use a "Vee" configuration instead of the XY configuration.

Both sets of tubes would be at 45 degrees from the vertical, and still cross at 90 degrees. Now the hydrostatic pressures are close to balanced at all contact points, and a set of bookends will keep the PVC stresses throughout the detector at very low levels.

Extra Costs and Complications

The middle bookend (s) create a discontinuity in detector response. This can be partially mitigated by making the bookend low mass.
We are not used to live in houses with 45 degree floors.
This makes us quite suspicious of the whole idea.
For instance, how do you pour and "level" a 45 degree concrete floor?
This will be addressed below.
There is not a vast level floor area for material preparation and storage. However, storage works well on sloped floor, and preparation work can be done on the rolling platform, if it is large enough.
The building gets wider, by about 40 percent.
It is a matter of point of view if the building gets also higher; this depends where one measures from.
It would seem to be harder to work in a building with no level floor. It is almost like a roofing job, only inverted. This will also be addressed below.
The electronics must be supported near the extrusion "snouts", and must be readily accessible during construction and afterwards. The same type of access is needed for the oil filling task. Such supports will be needed on two faces, rather than the top only. However, supporting this scaffolding may be easier in the VEE configuration.
All this will be addressed below as well.
Tubes can only be fully filled after both bookends are installed. However, partial filling is fine, and allows complete checkout of the electronics and readout system.

Fringe Benefits

Some fringe benefits can be expected:
The maximum hydrostatic pressure is reduced by 30 %.
All extrusions and snouts are identical.
No problems with filling and with trapped bubbles in horizontal tubes.
If welding is used to join extrusion, then gravity helps push the next one down against the one below, minimizing gaps.
In case of leaks, all fluid will run down to the bottom channel for easy collection and credible and inexpensive confinement.

How to make a 45 degree concrete floor

Sloping floors are not common.
They do occur along canals and around bridge supports, and I don't know how they make those. We also need a fair degree of accuracy for those floors.
Here is a scheme that I expect would work, and keep the cost reasonable:
First the Vee is excavated . This is not an uncommon task.

Next three rails are installed on grouted pads, one at the bottom of the Vee and two along the two sides, at ground level. These are standard railroad rails.
A “pouring machine “ is put together (see Fig. 2), which consists of a channel or pipe with a slot at the bottom, and which is equipped with a tubular vibrator, possible sectioned, for the full length. The machine has driven wheels to move it slowly down the hall.
The machine does one side of the Vee at a time.
It gets filled with concrete through a big funnel at the upper end.
The vibrator is run just fast enough to cause the concrete to run down and exit the bottom slot. The bottom of the channel determines the final shape and makes for an accurate surface. Rebar and steel mesh can be pre-placed as needed.

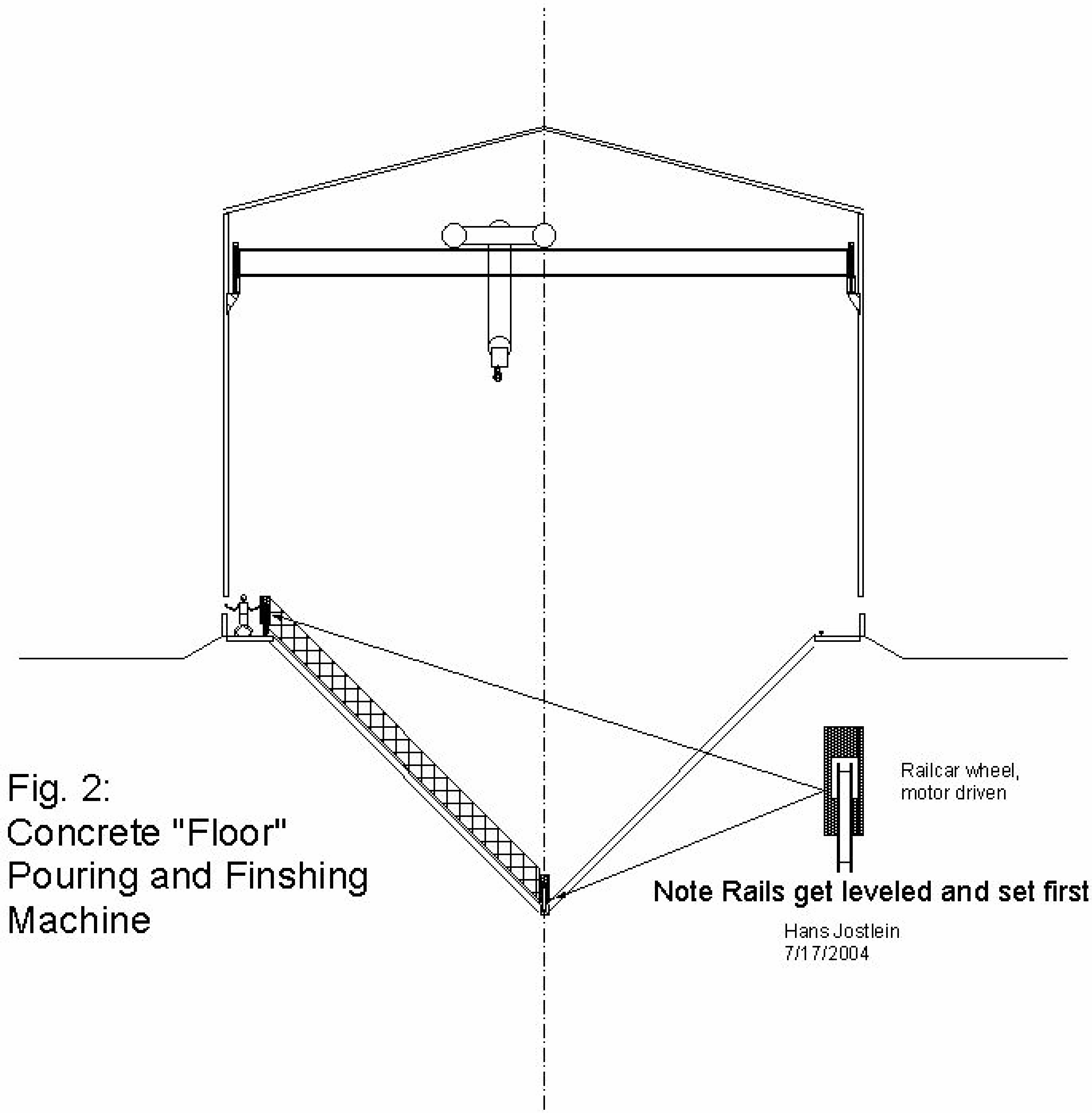

Fig. 2:
Concrete "Floor"
Pouring and Finshing
Machine

The Rolling Work Platform

Workers need to access the whole detector front during assembly.
A rolling platform can be devised that runs on the three rails already in place.
The platform can hold scaffolding, or one or two articulated lifts.
The platform can be self-driven, powered by propane (like the lifts would be).

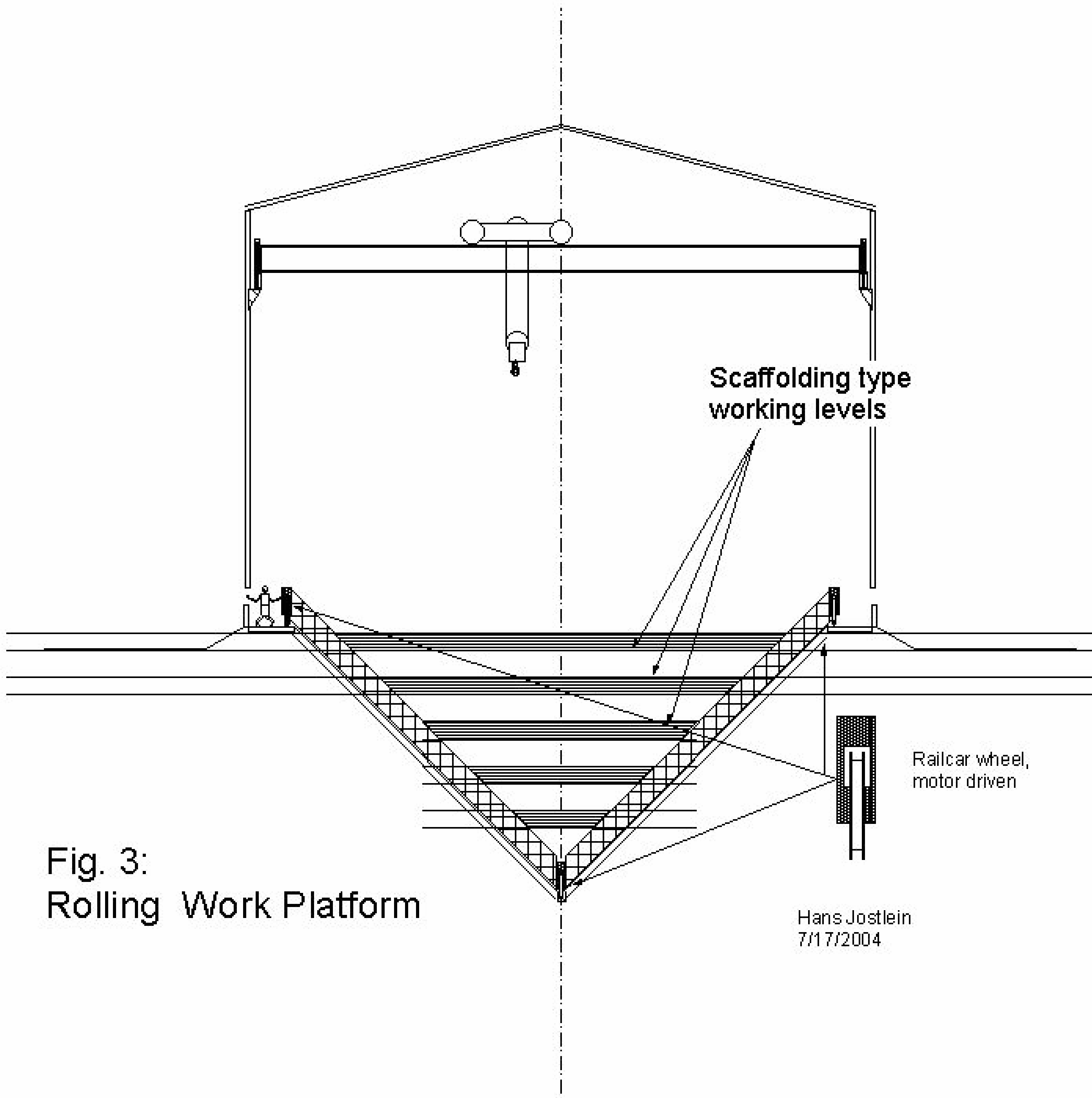

Fig. 3:
Rolling Work Platform

The Support and Access of Electronics

Electronics is distributed all over the detector and needs to be accessed during construction and operation. Access is also needed for oil filling.
There are two concepts that can be considered:

a. There is a permanent superstructure for support and access, see Fig. 4.
b. The electronics is supported directly by the extrusions, and additional support is needed only for personnel access. In this case the structure shown in Fig. 4 would

represent a mobile access cart (one may decide to make more than one, e.g. to do electronics and oil filling at the same time, in different places).

The structure is a stable” inverted Vee” truss which holds planks and ladders.

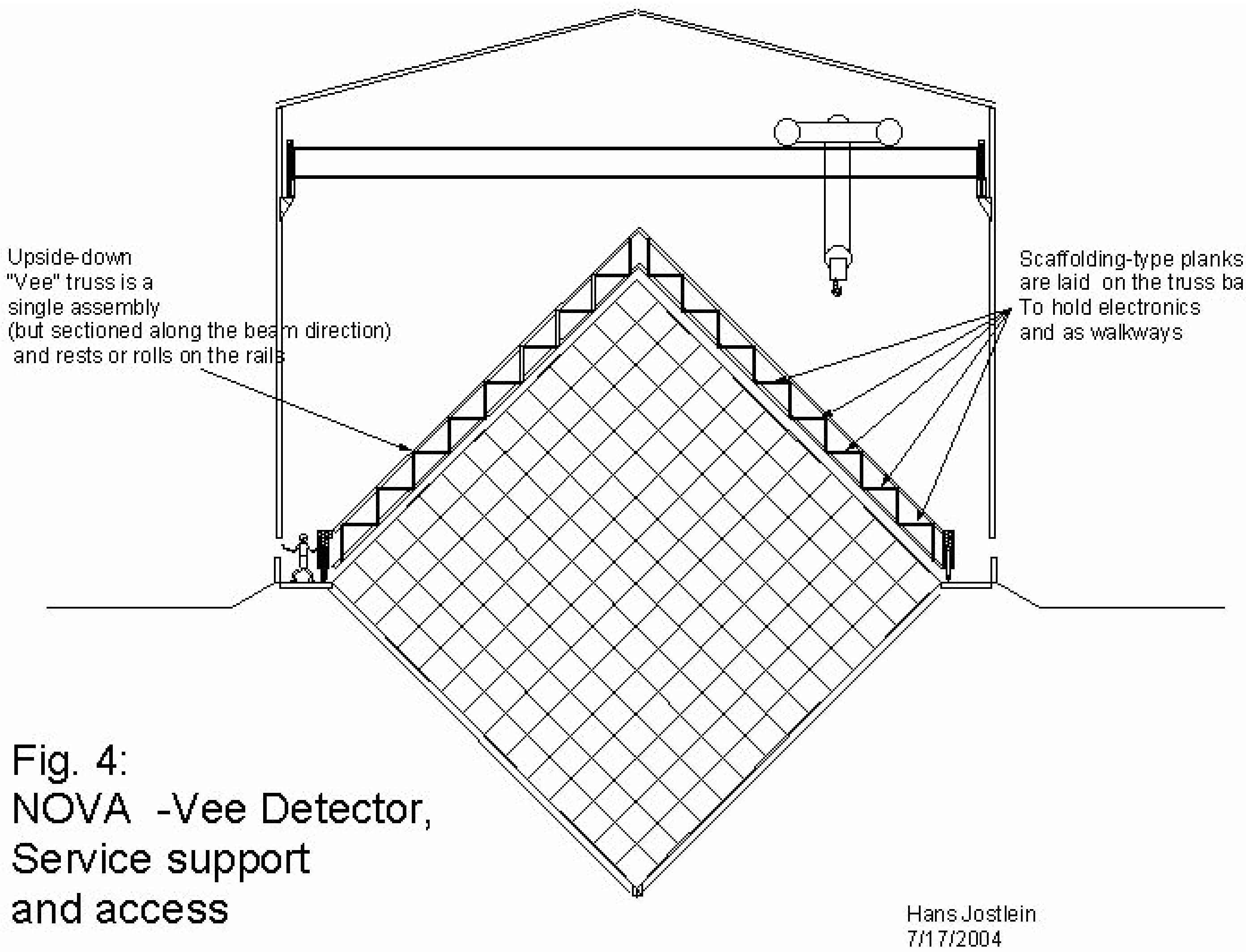

Fig. 4:
NOVA -Vee Detector,
Service support
and access